

**What is Claimed Is:**

1. Apparatus for applying coating liquid onto a surface moving in a given direction, comprising:

a coating liquid applicator having a passage;

means for flowing coating liquid through said applicator passage; and

a concave curved surface in communication with said applicator passage for flow of coating liquid from said passage onto said concave curved surface, said concave curved surface curving toward the moving surface and having a terminal portion spaced from and extending toward the moving surface in the direction of movement of and at an acute angle to the moving surface, the coating liquid flowing from said passage and along said concave curved surface in a sheet of coating liquid to subject the sheet of coating liquid to centrifugal force to concentrate coating liquid toward one surface of the coating liquid sheet that is toward said concave curved surface and to redirect the coating liquid sheet for flow from said terminal portion toward the moving surface in the direction of movement of and at an acute angle relative to the moving surface to cause the one surface of the coating liquid sheet that was toward said concave curved surface to impinge against the moving surface.

2. Apparatus as in claim 1, wherein the one surface of the coating liquid sheet that was toward said concave curved surface impinges against the moving surface while an opposite surface of the coating liquid sheet that was remote from said concave curved surface is out of substantial contact with the moving surface.

3. Apparatus as in claim 1, wherein said flowing means flows coating liquid through said passage onto and along said concave curved surface and from said

terminal portion such that upon the coating liquid sheet flowing from said terminal portion, coating liquid at the one surface of the coating liquid sheet flows substantially only toward the moving surface and is impinged against and carried away on the moving surface.

4. Apparatus as in claim 1, including means disposed downstream from said applicator for doctoring coating liquid on the moving surface.

5. Apparatus as in claim 3, wherein said apparatus applies coating liquid onto a surface moving in the given direction at a speed greater than about 2000 fpm.

6. Apparatus as in claim 1, wherein said applicator passage is oriented such that said flowing means flows coating liquid through said passage in a direction against the direction of movement of the moving surface and coating liquid flows from said passage onto said concave curved surface in a direction against the direction of movement of the moving surface.

7. Apparatus as in claim 1, including means disposed downstream from said applicator for doctoring coating liquid on the moving surface.

8. Apparatus as in claim 1, wherein said concave curved surface is defined within a bounded extension of said applicator passage.

9. Apparatus as in claim 1, wherein said concave curved surface and said terminal portion are defined within a bounded extension of said applicator passage and said flowing means flows coating liquid through said bounded extension such that upon the coating liquid sheet flowing from said terminal portion, coating liquid at the one surface of the coating liquid sheet flows substantially only toward the moving surface and is impinged against and carried away on the moving surface.

10. Apparatus as in claim 9, including means disposed downstream from said applicator for doctoring coating liquid on the moving surface.

11. Apparatus as in claim 9, wherein said apparatus applies coating liquid onto a surface moving in the given direction at a speed greater than about 2000 fpm.

12. Apparatus as in claim 1, wherein said curved surface is unbounded and downstream from said applicator passage.

13. Apparatus as in claim 12, including an unbounded straight surface in communication with and between said passage and said unbounded concave curved surface along which the sheet of coating liquid flows from said passage to said concave curved surface.

14. Apparatus as in claim 1, including a straight surface in communication with and between said concave curved surface and said terminal end for flow of coating liquid from said concave curved surface along said straight surface to and from said terminal end toward the moving surface.

15. Apparatus as in claim 1, wherein said curved surface is unbounded so that upon flow of the sheet of coating liquid along said curved surface the opposite surface of the sheet of coating liquid that is remote from said curved surface is exposed to ambient.

16. Apparatus as in claim 1, wherein said curved surface has an arcuate extent of no more than about 90°.

17. Apparatus as in claim 1, wherein said apparatus applies coating liquid onto a surface moving in the given direction at a speed greater than about 2000 fpm.

18. Apparatus as in claim 1, wherein the moving surface is a surface of a web moving in the given direction.

19. Apparatus as in claim 1, wherein said flowing means flows coating liquid through said passage onto and along said concave curved surface and from said terminal portion such that upon the coating liquid sheet flowing from said terminal portion, coating liquid at the one surface of the coating liquid sheet flows toward the moving surface without return to said terminal portion and is carried away on the moving surface.

20. Apparatus for applying coating liquid onto a surface moving in a given direction, comprising:

a coating liquid applicator having a flow path including a concave curved surface; and

means for flowing coating liquid along said flow path and said concave curved surface of said flow path, said concave curved surface curving toward the moving surface and leading to a terminal portion of said flow path spaced from and extending toward the moving surface in the direction of movement of and at an acute angle to the moving surface, the coating liquid flowing along said concave curved surface in a sheet of coating liquid to subject the sheet of coating liquid to centrifugal force to cause air that may be in the coating liquid sheet to move away from one side of the coating liquid sheet that is toward said concave curved surface and toward an opposite side of the coating liquid sheet that is remote from said concave curved surface and to cause coating liquid to move and concentrate toward the one side of the coating liquid sheet,

said concave curved surface redirecting the coating liquid sheet for flow in the direction of movement of the moving surface,

said flowing means flowing the coating liquid at a velocity sufficient to direct the coating liquid sheet from said flow path terminal portion toward the moving surface in the direction of movement of and at an acute angle relative to the moving surface to cause the one side of the coating liquid sheet that was toward said concave curved surface to have primary contact with and to apply onto the moving surface a layer of coating liquid that is relatively free of air.

21. Apparatus as in claim 20, wherein said flowing means flows coating liquid along said flow path and said concave curved surface of said flow path and from said flow path terminal portion such that upon the coating liquid sheet flowing from said terminal portion, coating liquid at the one surface of the coating liquid sheet flows substantially toward the moving surface and is contacted with and carried away on the moving surface.

22. Apparatus as in claim 21, including means disposed downstream from said applicator for doctoring coating liquid on the moving surface.

23. Apparatus as in claim 21, wherein said apparatus applies coating liquid onto a surface moving in the given direction at a speed greater than about 2000 fpm.

24. Apparatus as in claim 20, wherein said flow path extends relative to the moving surface such that coating liquid flowing along said flow path upstream from said concave curved surface flows in a direction against the direction of movement of the moving surface.

25. Apparatus as in claim 20, including doctor means disposed downstream from said applicator for doctoring the layer of coating liquid on the moving surface.

26. Apparatus as in claim 20, wherein said concave curved surface is bounded along an enclosed portion of said applicator flow path.

27. Apparatus as in claim 20, wherein said concave curved surface and said terminal portion are bounded along an enclosed portion of said applicator flow path and said flowing means flows coating liquid through said bounded extension such that upon the coating liquid sheet flowing from said terminal portion, coating liquid at the one side of the coating liquid sheet flows substantially toward the moving surface and is impinged against and carried away on the moving.

28. Apparatus as in claim 27, including means disposed downstream from said applicator for doctoring coating liquid on the moving surface.

29. Apparatus as in claim 27, wherein said apparatus applies coating liquid onto a surface moving in the given direction at a speed greater than about 2000 fpm.

30. Apparatus as in claim 20, wherein said concave curved surface is unbounded along an unenclosed portion of said applicator flow path, such that upon flow of the sheet of coating liquid along said concave curved surface the opposite side of the coating liquid sheet remote from said concave curved surface is exposed to ambient.

31 Apparatus as in claim 20, wherein said flow path includes an unbounded straight surface upstream from said unbounded concave curved surface and along which the sheet of coating liquid flows to said concave curved surface.

32. Apparatus as in claim 20, wherein said curved surface has an arcuate extent of no more than about 90°.

33. Apparatus as in claim 20, wherein said flow path includes a straight surface between said concave curved surface and said flow path terminal portion, said flowing means flowing coating liquid from said concave curved surface onto and along said straight surface to and from said terminal portion.

34. Apparatus as in claim 20, wherein said apparatus applies coating liquid onto a surface moving in the given direction at a speed greater than about 2000 fpm.

35. Apparatus as in claim 20, wherein the moving surface is a surface of a web moving in the given direction.

36. Apparatus as in claim 20, wherein said flowing means flows coating liquid along said flow path and said concave curved surface of said flow path and from said flow path terminal portion such that upon the coating liquid sheet flowing from said terminal portion, coating liquid at the one surface of the coating liquid sheet flows from said terminal portion to the moving surface without return to said terminal portion and is carried away on the moving surface.

37. Apparatus for applying coating liquid onto a moving surface, comprising:  
a coating liquid applicator having front and rear walls, a coating liquid passage between said front and rear walls, said passage having a downstream laterally elongate coating liquid outlet orifice, and a laterally elongate coating liquid deflector downstream from said outlet orifice and positioned proximate to, spaced from and transversely of the moving surface, said coating liquid deflector having a laterally elongate concave curved surface;

means for introducing coating liquid into said passage for flow through said passage to and through said laterally elongate outlet orifice and then to and along said

deflector concave curved surface in a laterally elongate sheet of coating liquid for being projected from and beyond a downstream end of said deflector in a free standing laterally elongate sheet of coating liquid that is directed toward, across and against the moving surface to provide a layer of coating liquid on the moving surface,

said introducing means flowing the coating liquid through said passage and orifice and along said deflector concave curved surface at a velocity that is sufficient, when taken together with a radius of curvature of said curved surface, to subject the coating liquid sheet to centrifugal force of a magnitude to cause air that may be in the coating liquid to move away from one side of the coating liquid sheet that is toward said concave curved surface and toward an opposite other side of the coating liquid sheet remote from said concave curved surface and to cause coating liquid to move and concentrate toward the one side of the coating liquid sheet toward said concave curved surface, so that the one side of the coating liquid sheet is relatively free of air as compared to the opposite side.

38. Apparatus as in claim 37, wherein the coating liquid sheet is projected toward, across and against the moving surface such that the one side of the coating liquid sheet that was toward said concave curved surface impinges against the moving surface while the opposite surface of the coating liquid sheet that was remote from said concave curved surface is out of substantial contact with the moving surface.

39. Apparatus as in claim 37, wherein said introducing means flows coating liquid through said passage and said outlet orifice and along said concave curved surface and from and beyond said downstream end of said deflector such that upon the coating liquid sheet flowing from said deflector downstream end, coating liquid at the



one side of the coating liquid sheet flows substantially toward the moving surface and is directed against and carried away on the moving surface.

40. Apparatus as in claim 39, including means disposed downstream from said applicator for doctoring coating liquid on the moving surface.

41. Apparatus as in claim 39, wherein said apparatus applies coating liquid onto a surface moving in the given direction at a speed greater than about 2000 fpm.

42. Apparatus as in claim 37, wherein said concave curved surface is bounded from said laterally elongate outlet orifice to said downstream end of said deflector and the coating liquid sheet is projected toward, across and against the moving surface to contact the moving surface primarily with the one side of the coating liquid sheet and such that upon the coating liquid sheet flowing from said deflector downstream end, coating liquid at the one side of the coating liquid sheet flows substantially toward the moving surface for being impinged against and carried away on the moving surface.

43. Apparatus as in claim 42, including means disposed downstream from said applicator for doctoring coating liquid on the moving surface.

44. Apparatus as in claim 42, wherein said apparatus applies coating liquid onto a surface moving in the given direction at a speed greater than about 2000 fpm.

45. Apparatus as in claim 37, wherein the layer of coating liquid is applied in excess on the moving surface and including means disposed downstream from said applicator for doctoring the excess layer of coating liquid on the moving surface.

46. Apparatus as in claim 37, wherein said means for introducing coating liquid comprises a coating liquid supply that includes an air removal device for removing

from the coating liquid an amount of air that is entrained in the coating liquid prior to introduction of coating liquid into said passage.

47. Apparatus as in claim 37, wherein said concave curved surface has an arcuate extent of no more than about 90°.

48. Apparatus as in claim 37, including a laterally elongate straight surface between said outlet orifice and said laterally elongate concave curved surface, such that the coating liquid flows in a laterally elongate sheet of coating liquid along said straight surface before flowing along said deflector curved surface for being projected from and beyond a downstream end of said deflector in a free standing laterally elongate sheet of coating liquid, so that the path followed by the coating liquid sheet after flowing through said orifice is straight leading to said deflector curved surface, curved in one direction only along said deflector curved surface and straight from said deflector downstream end to the moving surface, whereby centrifugal force to which the coating liquid sheet is subjected is exerted in one direction only and always causes air that may be entrained in the coating liquid sheet to move away from, not toward, the one side of the coating liquid sheet.

49. Apparatus as in claim 37, wherein said laterally elongate coating liquid deflector is oriented relative to the moving surface such that an included angle between the one side of the free standing laterally elongate sheet of coating liquid and a tangent to the moving surface at a point of contact of the liquid sheet with the moving surface is acute, and such that an included angle between the opposite side of the free standing sheet of coating liquid and the tangent to the moving surface is obtuse.

50. Apparatus as in claim 37, wherein the moving surface is a surface of a web moving in the given direction.

51. Apparatus for applying coating liquid onto a moving surface, comprising:  
a coating liquid applicator having a flow path including at least one portion that changes in direction; and

means for flowing coating liquid along said flow path and said at least one portion of said flow path, said at least one portion leading to a terminal portion of said flow path spaced from and extending toward the moving surface in the direction of movement of and at an acute angle to the moving surface, the coating liquid flowing along said at least one portion of said flow path in a sheet of coating liquid to subject the coating liquid sheet to centrifugal force to cause coating liquid to concentrate toward one side of the coating liquid sheet,

said flowing means flowing the coating liquid at a velocity sufficient to direct the coating liquid sheet from said flow path terminal portion toward the moving surface in the direction of movement of and at an acute angle relative to the moving surface to cause the one side of the coating liquid sheet to have primary contact with and to apply onto the moving surface a layer of coating liquid that is relatively free of air.

52. Apparatus as in claim 51, wherein said flowing means flows coating liquid along said flow path and said at least one portion of said flow path and from said flow path terminal portion such that upon the coating liquid sheet flowing from said terminal portion, coating liquid at the one side of the coating liquid sheet flows substantially toward the moving surface and is contacted with and carried away on the moving surface.

53. Apparatus as in claim 52, including means disposed downstream from said applicator for doctoring coating liquid on the moving surface.

54. Apparatus as in claim 52, wherein said apparatus applies coating liquid onto a surface moving in the given direction at a speed greater than about 2000 fpm.

55. Apparatus as in claim 51, wherein said flow path includes at least one straight portion, so that all portions of said flow path are either straight or change in direction such that the coating liquid sheet is subjected to centrifugal force that causes coating liquid to concentrate only toward the one side of the coating liquid sheet.

56. Apparatus as in claim 51, wherein said at least one portion of said flow path is at least one curved portion of said flow path.

57. Apparatus as in claim 56, wherein said at least one curved portion of said flow path is at least one concave curved portion of said flow path.

58. Apparatus as in claim 57, wherein said at least one concave curved portion and said terminal portion of said flow path are in a bounded portion of said flow path and said flowing means flows coating liquid along said bounded portion such that upon the coating liquid sheet flowing from said terminal portion, coating liquid at the one surface of the coating liquid sheet flows substantially toward the moving surface and is contacted with and carried away on the moving surface.

59. Apparatus as in claim 58, including means disposed downstream from said applicator for doctoring coating liquid on the moving surface.

60. Apparatus as in claim 58, wherein said apparatus applies coating liquid onto a surface moving in the given direction at a speed greater than about 2000 fpm.

61. Apparatus as in claim 51, including doctor means disposed downstream from said applicator for doctoring the layer of coating liquid on the moving surface.

62. Apparatus as in claim 51, wherein said apparatus applies coating liquid onto a surface moving at a speed greater than about 2000 fpm.

63. Apparatus as in claim 51, wherein the moving surface is a surface of a moving web.

64. A method of applying coating liquid onto a surface moving in a given direction, comprising:

flowing coating liquid through a passage;

flowing the coating liquid from the passage onto a concave curved surface that curves toward the moving surface and has a terminal portion spaced from and extending toward the moving surface in the direction of movement of and at an acute angle to the moving surface;

flowing the coating liquid from the passage along the concave curved surface to form a sheet of coating liquid on the curved surface, to subject the sheet of coating liquid to centrifugal force to concentrate coating liquid toward one side of the coating liquid sheet that is toward the concave curved surface, and to redirect the coating liquid sheet for flow in the direction of movement of the moving surface; and

directing the coating liquid sheet from the terminal portion toward and in the direction of movement of and at an acute angle relative to the moving surface to contact the moving surface with the one side of the coating liquid sheet that was toward the curved surface to apply onto the moving surface a layer of coating liquid.

65. A method as in claim 64 wherein said directing step operates to contact the moving surface with the one side of the coating liquid sheet that was toward the curved surface while maintaining an opposite side of the coating liquid sheet that was away from the curved surface out of substantial contact with the moving surface.

66. A method as in claim 64, wherein said flowing and directing steps flow coating liquid through the passage and along the concave curved surface and from the terminal portion such that upon the coating liquid flowing from the terminal portion, coating liquid at the one side of the coating liquid sheet flows substantially only toward the moving surface and is contacted with and carried away on the moving surface.

67. A method as in claim 66, including the step of doctoring the coating liquid on the moving surface.

68. A method as in claim 66, wherein coating liquid is applied onto a surface moving in the given direction at a speed greater than about 2000 fpm.

69. A method as in claim 64, wherein said step of flowing coating liquid through a passage comprises flowing coating liquid through a passage extending in a direction against the direction of movement of the moving surface, and said step of flowing coating liquid from the passage onto the concave curved surface comprises flowing the coating liquid from the passage and onto the concave curved surface in a direction against the direction of movement of the moving surface.

70. A method as in claim 64, including the step of doctoring the coating liquid on the moving surface.

71. A method as in claim 64, wherein the concave curved surface is bounded within an enclosed length of the passage.

72. A method as in claim 71, wherein the concave curved surface and the terminal portion are bounded within the enclosed length of the passage and said flowing step flows coating liquid through the enclosed length of the passage such that upon the coating liquid sheet flowing from the terminal portion, coating liquid at the one side of the coating liquid sheet flows substantially only toward the moving surface and contacts and remains on the moving surface.

73. A method as in claim 72, including the step of doctoring the coating liquid on the moving surface.

74. A method as in claim 72, wherein coating liquid is applied onto a surface moving in the given direction at a speed greater than about 2000 fpm.

75. A method as in claim 74, wherein the concave curved surface is unbounded along an unenclosed length of the passage.

76. A method as in claim 62, wherein the concave curved surface has an arcuate extent of no more than about 90°.

77. A method as in claim 74, wherein said step of flowing the coating liquid from the passage along the concave curved surface flows the coating liquid along a straight surface extending between the curved surface and the terminal portion.

78. A method as in claim 64, wherein coating liquid is applied onto a surface moving in the given direction at a speed greater than about 2000 fpm.

79. A method as in claim 64, wherein the moving surface is a surface of a web moving in the given direction.

80. A method as in claim 64, wherein said flowing and directing steps flow coating liquid through the passage and along the concave curved surface and from the

terminal portion such that upon the coating liquid flowing from the terminal portion, coating liquid at the one side of the coating liquid sheet flows toward the moving surface without return to the terminal portion and is carried away on the moving surface.

81. A method of applying coating liquid onto a surface moving in a given direction, comprising:

flowing coating liquid along a flow path that includes a concave curved surface that curves toward the moving surface and a terminal portion spaced from and extending toward the moving surface in the direction of movement of and at an acute angle to the moving surface;

forming the coating liquid flowing along the concave curved surface into a sheet of coating liquid on the concave curved surface to subject the sheet of coating liquid to centrifugal force to cause air that may be in the coating liquid sheet to move away from one side of the coating liquid sheet that is toward the concave curved surface and toward an opposite side of the coating liquid sheet that is remote from the concave curved surface and to cause coating liquid to move and concentrate toward the one side of the coating liquid sheet, the concave curved surface redirecting the coating liquid sheet for flow in the direction of movement of the moving surface; and

directing the coating liquid sheet from the terminal portion toward and in the direction of movement of and at an acute angle relative to the moving surface to cause the one side of the coating liquid sheet that was toward the concave curved surface to have primary contact with and to apply onto the moving surface a layer of coating liquid that is relatively free of air.



82. A method as in claim 81, wherein said flowing, forming and directing steps cause the one side of the coating liquid sheet that was toward the concave curved surface to have primary contact with the moving surface while maintaining the opposite side of the coating liquid sheet that was remote from the concave curved surface out of substantial contact with the moving surface.

83. A method as in claim 81, wherein said flowing, forming and directing steps flow coating liquid along the flow path and the concave curved surface and from the terminal portion such that upon the coating liquid sheet flowing from the terminal portion, coating liquid at the one side of the coating liquid sheet flows substantially toward the moving surface and is contacted with and carried away on the moving surface.

84. A method as in claim 83, including the step of doctoring coating liquid on the moving surface.

85. A method as in claim 83, wherein coating liquid is applied onto a surface moving in the given direction at a speed greater than about 2000 fpm.

86. A method as in claim 81, wherein said step of flowing coating liquid along the flow path comprises flowing coating liquid in a direction against the direction of movement of the moving surface prior to flowing the coating liquid along the concave curved surface.

87. A method as in claim 81, including the step of doctoring the coating liquid on the moving surface.

88. A method as in claim 81, wherein the concave curved surface is bounded along an enclosed length of the flow path.

89. A method as in claim 81, wherein both the concave curved surface and the terminal portion are bounded along an enclosed length of the flow path and said flowing step flows coating liquid along the enclosed length of the flow path such that upon the coating liquid sheet being directed from the terminal portion, coating liquid at the one side of the coating liquid sheet flows substantially toward the moving surface and contacts and remains on the moving surface.

90. A method as in claim 89, including the step of doctoring the coating liquid on the moving surface.

91. A method as in claim 89, wherein coating liquid is applied onto a surface moving in the given direction at a speed greater than about 2000 fpm.

92. A method as in claim 81, wherein the concave curved surface is unbounded along an unenclosed length of the flow path.

93. A method as in claim 81, wherein the concave curved surface has an arcuate extent of no more than about 90°.

94. A method as in claim 81, wherein said step of flowing the coating liquid along the flow path flows the coating liquid along a straight surface of the flow path extending between the curved surface and the terminal portion.

95. A method as in claim 81, wherein coating liquid is applied onto a surface moving in the given direction at a speed greater than about 2000 fpm.

96. A method as in claim 81, wherein the moving surface is a surface of a web moving in the given direction.

97. A method as in claim 81, wherein said flowing, forming and directing steps flow coating liquid along the flow path and the concave curved surface and from the

terminal portion such that upon the coating liquid sheet flowing from the terminal portion, coating liquid at the one side of the coating liquid sheet flows from the terminal portion to the moving surface without return to the terminal portion and is carried away on the moving surface.

98. A method of applying coating liquid onto a moving surface, comprising:  
flowing coating liquid along an elongate concave curved surface that is positioned proximate to, spaced from and transversely of the moving surface to subject the coating liquid to centrifugal force that causes air that may be in the coating liquid to move away from the concave curved surface and coating liquid to move and concentrate toward the concave curved surface; and

directing the coating liquid, after it has flowed along the curved surface, in a free standing elongate jet curtain of coating liquid toward, across and against the moving surface to contact the moving surface primarily with one side of the jet curtain of coating liquid that was toward the curved surface to apply an excess layer of coating liquid onto the moving surface,

wherein said flowing step comprises flowing the coating liquid along the concave curved surface at a velocity that is sufficient, when taken together with a radius of curvature of the curved surface, to subject the coating liquid to centrifugal force of a magnitude that causes air that may be in the coating liquid to move away from one side of the coating liquid that is toward said curved surface and toward an opposite side of the coating liquid that is remote from the curved surface, so that the one side of the coating liquid is relatively free of air.

99. A method as in claim 98, wherein said directing step operates to contact the moving surface primarily with the one side of the jet curtain of coating liquid that was toward the curved surface while maintaining an opposite side of the jet curtain of coating liquid that was remote from the curved surface out of substantial contact with the moving surface.

100. A method as in claim 98, wherein said flowing and directing steps operate such that upon the coating liquid being directed in an elongate jet curtain toward, across and against the moving surface, the coating liquid at the one side of the jet curtain of coating liquid travels substantially toward the moving surface and flows against and is carried away on the moving surface.

101. A method as in claim 100, including the step of doctoring coating liquid on the moving surface.

102. A method as in claim 100, wherein coating liquid is applied onto a surface moving in the given direction at a speed greater than about 2000 fpm.

103. A method as in claim 98, wherein the concave curved surface is bounded and said flowing and directing steps operate such that, upon the jet curtain of coating liquid being directed toward the moving surface, coating liquid at the one side of the jet curtain of coating liquid flows substantially toward the moving surface and flows against and remains on the moving surface.

104. A method as in claim 103, including the step of doctoring the excess layer of coating liquid on the moving surface.

105. A method as in claim 103, wherein coating liquid is applied onto a surface moving in the given direction at a speed greater than about 2000 fpm.

106. A method as in claim 98, wherein said flowing step comprises delivering coating liquid under pressure to an elongate outlet nozzle, emitting the coating liquid from the elongate outlet nozzle in an elongate sheet of coating liquid, and flowing the elongate sheet of coating liquid emitted from the outlet nozzle along an elongate straight surface and then off of the straight surface and onto and along the elongate curved surface to subject the coating liquid sheet to centrifugal force.

107. A method as in claim 98, including the step, performed prior to said flowing step, of causing the coating liquid to flow through an air removal device that removes from the coating liquid an amount of entrained air.

108. A method as in claim 98, wherein the curved surface has an arcuate extent of no more than about 90°.

109. A method as in claim 98, wherein the curved surface has a radius in the range of about 0.125 inch to 0.500 inch.

110. A method as in claim 98, wherein the moving surface is a surface of a moving web.

111. A method as in claim 98, including the step of doctoring the excess layer of coating liquid on the moving surface.

112. A method as in claim 98, wherein coating liquid is applied onto a surface moving in the given direction at a speed greater than about 2000 fpm.

113. A method of applying coating liquid onto a moving surface, comprising:  
flowing coating liquid along a flow path that includes at least one portion that changes in direction and leads to a terminal portion of the flow path spaced from and

extending toward the moving surface in the direction of movement of and at an acute angle to the moving surface;

forming the coating liquid flowing along the at least one portion of the flow path into a sheet of coating liquid on the at least one portion to subject the coating liquid sheet to centrifugal force to cause coating liquid to concentrate toward one side of the coating liquid sheet; and

directing the coating liquid sheet from the terminal portion toward, in the direction of movement of and at an acute angle relative to the moving surface to cause the one side of the coating liquid sheet to have primary contact with and to apply onto the moving surface a layer of coating liquid.

114. A method as in claim 113, wherein said flowing step flows the coating liquid along a flow path that also includes at least one straight portion, so that all portions of the flow path are either straight or change in direction and such that the coating liquid sheet is subjected to centrifugal force that causes coating liquid to concentrate only toward the one side of the coating liquid sheet.

115. A method as in claim 113, wherein said flowing step flows the coating liquid along a flow path in which the at least one portion of the flow path is at least one curved portion of the flow path.

116. A method as in claim 113, wherein said flowing, forming and directing steps operate such that upon the coating liquid sheet flowing from the flow path terminal portion, coating liquid at the one side of the coating liquid sheet flows substantially toward the moving surface and is contacted with and carried away on the moving surface.

117. A method as in claim 116, including the step of doctoring coating liquid on the moving surface.

118. A method as in claim 116, wherein coating liquid is applied onto a surface moving in the given direction at a speed greater than about 2000 fpm.

119. A method as in claim 113, wherein said flowing step flows the coating liquid along a flow path in which the at least one portion of the flow path is at least one curved portion of the flow path.

120. A method as in claim 119, wherein the at least one curved portion of the flow path is at least one concave curved portion of the flow path.

121. A method as in claim 120, wherein the at least one concave curved portion and the terminal portion are bounded within an enclosed length of the flow path and said flowing step flows coating liquid along the enclosed length of the flow path such that, upon the coating liquid sheet being directed from the flow path terminal portion, the one side of the coating liquid sheet flows substantially toward the moving surface and contacts and remains on the moving surface.

122. A method as in claim 121, including the step of doctoring the coating liquid on the moving surface.

123. A method as in claim 121, wherein coating liquid is applied onto a surface moving in the given direction at a speed greater than about 2000 fpm.

124. Apparatus as in claim 113, including the step of doctoring the layer of coating liquid on the moving surface.

125. Apparatus as in claim 113, wherein the moving surface is moving at a speed greater than about 2000 fpm.

126. A method as in claim 113, wherein the moving surface is a surface of a moving web.